

# Gender Based Variation in Audiometric Findings in Relation with Waist Circumference

Samina Sheikh, Rubina Ahmedani, Tazeen Shah

## ABSTRACT

**BACKGROUND:** Hearing loss has been reported linked with the physical obesity. Waist circumference (WC) is one of the calculated ratios that have been proposed to be used for assessing obesity. It is stated that the WC provides clue for central obesity which is a risk factor of hearing loss.

**OBJECTIVE:** The present study intended to determine the gender base variation in audiometric findings in relation with increased waist circumference and percentage of study population suffering from hearing loss associated with increased waist circumference.

**METHODS:** The present Cross sectional / comparative study was conducted at Research Laboratory, Department of Physiology, Liaquat University of Medical and Health Sciences (LUMHS) Jamshoro. A sample of 226 was divided into; Group A. Female (n=113) and Group B. Male (n=113). Group A and B were further divided into A<sub>1</sub>, A<sub>2</sub>, A<sub>3</sub> and B<sub>1</sub>, B<sub>2</sub> and B<sub>3</sub> according to the WC. The WC was measured by measuring tape halfway between the lower costal margin and the iliac crest. The Audiometry was performed on Audiometer MAICO® MA-39 BERLIN GERMANY at the Power Lab of Department of Physiology Pure tone Audiometry (PTA >25 Db) was considered as deafness. The data was entered and analyzed on the statistical program SPSS version 22.0. (IBM, Incorporation, USA) using Student's t-test and Chi square test.

**RESULTS:** Male to female ratio was 1:1. WC in sub groups showed statistically significant differences among A1-A3 female and B1-B3 male groups (P=0.0001). Average PTA was measured as deci-Bells (dB). Taken 25 dB PTA as reference, PTA showed statistically significant differences among A1-A3 female and B1-B3 male groups (P=0.0001). The results show significant tendency of hearing loss with increasing WC particularly the high frequency sounds.

**CONCLUSION:** The present study reports female gender and increased waist circumference as risk factors for the hearing threshold loss. The Waist circumference, a surrogate marker of body adiposity, may be exploited clinically for the prediction of hearing problems in the obese subjects.

**KEYWORDS:** Waist circumference, Gender, Hearing Loss, Pure tone Audiometry.

*This article may be cited as:* Sheikh S, Ahmedani R, Shah T. Gender Based Variation in Audiometric Findings in Relation with Waist Circumference. J Liaquat Uni Med Health Sci. 2018;17 (02):91-5. doi: 10.22442/jlumhs.181720557

## INTRODUCTION

According to reports of World Health Organization, approximately 360 million people are suffering from hearing loss (HL). HL has many causes including aging, obesity, ear infections or inborn genetic errors, etc<sup>1</sup>. Obesity is an established risk of increased frequency of HL. The physiological association of HL due to obesity include the; ischemia, hypoxia, reactive oxygen species (ROS) load and oxidative stress. The oxidative stress damages the hair cells, cochlear cells and spiral ganglion cells and this eventually steals the hearing of a person<sup>1,2</sup>. The suggestive pathophysiology is stated as the portion of inner ears has complex semi-circular tubes with fluid and nerve endings. The auditory hair cells are the basic structure responsible for detecting sound, translating it into electrical signals and to transmit it to the brain. Once these hair cells are damaged, they cannot be regenerated and

hearing loss is permanent, a healthy blood supply and oxygen are required for the proper functioning of these hair cells, but as obesity puts a huge tension on the walls of capillaries, the oxygen as well as blood cannot be transported efficiently to the hair cells leading to permanent damage of hair cells and complete hair loss<sup>3</sup>.

Deafness means hearing loss (HL), is defined as a degree of impairment of hearing, so that a person is not able to understand the speech, and in its severe form even in the presence of amplification.<sup>2</sup> Conductive HL is a condition in which there is failure to transmit sound waves from external ear through the middle ear due to an impedance in its pathway as wax plug impinging and blocking the auditory meatus completely. This type of HL is very common<sup>3</sup> Sensorineural HL is a pathophysiological condition in which the sound waves fail to stimulate the cochlea

due to cochlear or nerve disease, auditory pathways or central auditory cortex defect. Sensorineural HL is defined as an average loss of pure tone level >15 dB for 0.5, 1 and 2 kHz (low frequency) and 3, 4, 6, and 8 KHz (high frequency)<sup>3</sup>. Currently, a link of hearing loss and physical obesity has been reported. Obesity is the presence of body fat. Obesity is derived from *Latin* word "obesus" that means excessive fatty due to excessive eating<sup>4</sup>. Quetlet index or body mass index (BMI) is a weight based measurement of a person's body mass and height. Basal metabolic index and waist circumference (WC) are simple methods for assessing body weight. The WC used for persons with a departure of body weight away from what is normal or desirable. All of above methods and mathematical calculation formulas have limitations. Limitations are now established in certain conditions. Thus alter-native methods are used in cases of perceived problematic basal metabolic index. Waist circumference (WC) is one of the calculated parameter that has been proposed to be used for assessing obesity<sup>5</sup>. WC in obese persons is reported to produce acquired hearing loss. Prevalence is reported to be very high in persons who have increased WC. Waist circumference (WC) >88 cm showed relative risk (RR) of 1.17-1.38 as analyzed by the multivariate adjusted analysis (95% CI). For women with WC of 80- 88cm, the risk for HL was >11%. While for WC >88 cm, the risk of HL was increased to >27%<sup>6,7</sup>. This means large WC is associate and a risk factor for the HL, which may be due to the impairment of cochlear physiology. One suggested mechanism of HL in obesity is the compromised vascular supply, capillary constriction, cellular damage and deafness. Stria vascularises show abnormal capillaries and vascular supply in obesity. Previous cross sectional studies had reported association of obesity with HL. It was reported that large WC is associated with threshold of poorer hearing<sup>6-8</sup>. A cut off values of WC are calculated as <71cm (71 -79), 80-88cm and >88cm<sup>9</sup>. Higher the WC, higher is the risk of hearing loss.<sup>7</sup> It is stated that the WC provides clue for central obesity which is a risk factor of hearing loss<sup>10</sup>.

### OBJECTIVES

To determine the gender base variation in audiometric findings in relation with increased waist circumference. To determine the percentage of study population suffering from hearing loss associated with increased waist circumference.

### HYPOTHESIS

The increased waist circumference causes hearing loss.

### METHODOLOGY

**STUDY DESIGN:** Cross sectional study.

**SETTING:** The present study was conducted at Research Laboratory Physiology Department, Liaquat University of Medical and Health Sciences (LUMHS) Jamshoro. The medical students and employees of LUMHS were recruited in this study.

**DURATION:** Six months after approval of synopsis. Jan 2016 to June 2016

### SAMPLE SIZE

Total sample size n= 226 have been calculated from the study population (n) based on assumptions of CI=95% and margin of error=5% p= 18% (prevalence of obesity 13% in men and 23% women in previous studies and average was 18% in previous study conducted in Pakistan).<sup>11</sup> The study sample was 226 subjects.

### STUDY GROUPS

#### Group A

Group A is divided in to 3 subgroups, each subgroup consist of subjects of females according to waist circumference.

#### Group A – subgroups

- A1 has waist circumference 29-31 inches
- A2 has WC of 32-34 inches
- A3 has WC >34 inches

#### Group B

Group B also divided in to 3 subgroups each subgroup consist of subjects of male according to waist circumference.

#### Group B – subgroups

- B1 has WC 31-33 inches.
- B2 has WC 34-36 inches.
- B3 has WC >36 inches.

### INCLUSION CRITERIA

- Nonsmokers, non diabetic, non hypertensive.
- Adult males and females of age 18 to 35 years.

### EXCLUSION CRITERIA

- Individuals with history of taking ototoxic drugs.
- Repeated ear infections and discharge.
- Any congenital ear anomaly.
- Who has history of nerve deafness running in their family.

After informing and taking written consent from the subjects, self-administered questionnaire were filled regarding their previous medical history and physical activity. The subjects underwent routine measurements e.g. height, weight, pulse and blood pressure. Waist circumference was measured by measuring tape halfway between the lower costal margin and the iliac crest by using a flexible inch tape. Protocol of measuring waist circumference measurement

- Ensure that the subject is standing erect.
- Abdominal muscles are relaxed.
- Measurement is taken at the end of normal expiration.

- Locate the iliac crest of hip bone, measure above it where one finger fits between the iliac crest and the lowest rib cage.
- Measuring tape must be positioned horizontally (parallel to the floor). Now measure at a level just above the iliac crest, irrespective of whether the umbilicus is above or below the tape.

Do not make compressions in the skin with the tape measure. Specially designed abdominal circumference tape measure should be used for measuring WC. WC should be measured around the narrower part of the abdomen<sup>11</sup>. Then whisper test, Rinne's test, Webber's test, Shaw back test were performed on all young adult volunteers of different groups, otoscopy to exclude the disorders like otic trauma, external ear infections and ear discharge.

- The AUDIOMETRY was performed on audiometer MAICO® MA-39 BERLIN GERMANY at the power lab of department of physiology.
- For audiometry instructions were given to volunteers about the procedure and how the subject is required to indicate (Volunteers were asked to raise a hand, press a button, or otherwise indicate when they could hear a sound) whether he/she can just hear or cannot hear a certain sound (the sound level may be increased from a very low level or reduced from a high level).
- The subjects were asked to remove anything which might upset the test results, e.g. spectacles, earrings, hearing aids. The earphones attached to the audiometer were fitted carefully over the ears and the test was then carried out on each ear.

Pure tones of controlled intensity were delivered to one ear at a time. The minimum intensity (volume) required to hear each tone was graphed

#### ETHICAL CONSIDERATION

The study was conducted strictly under the ethical rules and after approval research ethics committee at LUMHS JAMSHORO.

#### DATA ANALYSIS

The data was entered and analyzed on the statistical program SPSS version 22.0. Continuous and categorical variables were analyzed by Student's t-test and Chi square test. Frequencies and percentage of the quantitative data were determined. Intensities and frequencies of sound were also determined. Group differences were measured and results were held significant at p value.

## RESULTS

#### Age Distribution

The mean  $\pm$  SD of study subjects in groups A and B was 26.21  $\pm$  5.27 and 26.43  $\pm$  5.11 years (t-value 0.32, p=0.0749).

- Study subjects were age matched as indicated by non-significant P-value (Table I).

#### Waist circumference in Subgroups

The WC in sub groups as shown in table II showed statistically significant differences among A1-A3 female and B1-B3 male groups (P=0.0001). A3 and B3 showed significant differences compared to group A1, A2, B1 and B2.

#### Pure Tone Audiometry (dB) in Subgroups

The PTA in sub groups showed great variation and hearing loss with increasing WC as shown in table III (P=0.0001). PTA showed statistically significant differences among A1-A3 female and B1-B3 male groups (P=0.0001). A3 and B3 showed significant differences compared to group A1, A2, B1 and B2.

#### PTA-Audiogram

The audiogram in graph I shows the tendency of hearing loss in sub groups A1-A3 and B1-B3 in comparison to sound frequency. Low frequency hearing loss was defined as <2000 Hz and high frequency hearing loss was defined as >2000 Hz. The results shows significant tendency of hearing with increasing WC particularly the high frequency sounds.

**TABLE I: AGE DISTRIBUTION OF STUDY POPULATION (n=226)**

Groups	Mean	$\pm$ SD	P- value
Group A (n=113)	26.21	5.27	0.0749
Group B (n=113)	26.43	5.11	

**TABLE II: WAIST CIRCUMFERENCE (INCHES) IN SUB GROUP (n=226)**

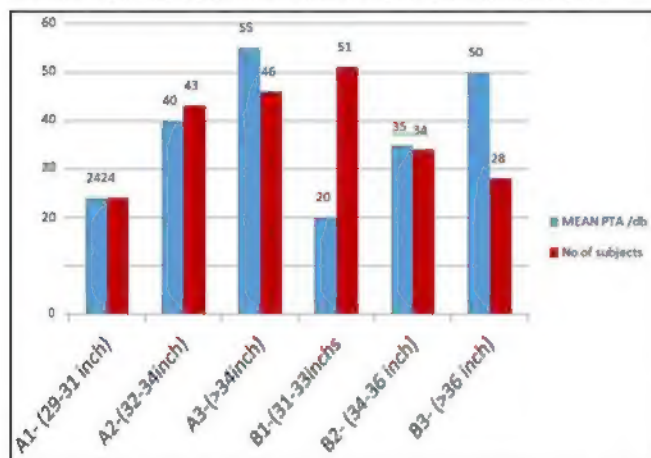
Groups	Subgroups	No: of subjects and (%)	Mean	$\pm$ SD	P- value
Group A (Female)	A1- (29-31 )	24 (21%)	30.02	0.86	0.0001
	A2- (32-34 )	43 (38%)	33.02	0.83	
	A3- (>34 )	46 (41%)	37.64	1.70	
Group B (Male)	B1- (31-33)	51 (45%)	32.02	0.82	
	B2- (34-36 )	34 (30%)	35.02	0.83	
	B3- (>36 )	28(25%)	37.94	1.65	

## DISCUSSION

The present study is the first research which evaluated the association of hearing loss with WC in young male and female population. The present study is first time reporting audiometric findings in young age matched male and female subjects. The majority of study subjects in present study were in their 3rd decade with mean age 26.21  $\pm$  5.27 and 26.43  $\pm$  5.11 years in female and male respectively

**TABLE III:  
PURE TONE AUDIOMETRY (dB) IN SUB GROUPS**

Groups	Sub groups	Mean	±SD	P-value
Group A female	A1 (29-31 inches)	24.3	3.56	0.0001
	A2 (32-34 inches)	40.0	4.07	
	A3 (>34 inches)	55.3	1.65	
Group B male	B1 (31-33 inches)	20.0	3.59	
	B2 (34-36 inches)	35.2	4.01	
	B3 (>36 inches)	50.1	1.40	

**GRAPH I: AUDIOGRAM SHOWING HEARING LOSS WITH INCREASING WAIST CIRCUMFERENCE**

Mean PTA and number of subjects in sub groups (n=22)

( $p=0.0749$ ). The age group was similar to study of Hwang et al<sup>6</sup> which include subjects of 3rd decade. The PTA in sub groups showed great variation and hearing loss with increasing WC as shown in table 6, ( $P=0.0001$ ). PTA showed significant hearing threshold loss with increasing WC. ( $P=0.0001$ ). The findings of WC are consistent with previous studies<sup>7,13</sup> but inconsistent to Hwang JH et al<sup>6</sup> and Fransen E et al<sup>7</sup>. The audiogram of present study (graph4) shows the tendency of hearing loss in sub groups A1-3 and B1-3 in comparison to sound frequency. Low frequency hearing loss was defined as <2000Hz and high frequency hearing loss was defined as >2000 Hz<sup>3</sup>. The results shows significant tendency of hearing loss with increasing WC particularly the high frequency sounds. The findings of WC are conducted by, Jung DJ et al, Curhan SG et al, Kang SH et al and Cruickshanks KJ et al, but inconsistent study carried by Fransen E et al. Ucler et al (2016)<sup>3</sup> has recently reported on the association of WC with hearing thresholds in young female subjects. Ucler et al reported positive link of hearing loss (HL) with obesity. Hence the results are supporting the present study. In the present study, the

link between WC and hearing loss in women aged 18-35 year of age. However, the Ucler et al<sup>3</sup> had studied female with 18-40 year of age. As the hearing loss (HL) is a social health problem which interferes with the normal life style<sup>17</sup>. HL is directly linked with the increased WC, has been reported by Fransen E et al and Cruickshanks KJ et al<sup>7,15</sup>.

Ko et al demonstrated that WC is better discriminator of adiposity and HL<sup>18</sup>. However, other previous studies<sup>19</sup> have reported conflicting results. This might be due to different ethnical and geographical segments and different age groups. Other cross-sectional studies found positive association of WC and HL<sup>7</sup>, the findings are consistent to present study. The present study enrolled Asian male and female of 18-35 years which is very young age suffering from obesity these days. The results of present study suggest that WC was highly associated with hearing loss and hearing threshold loss particularly in female<sup>20</sup>. These previous studies suggested increased frequency of HL and hearing threshold loss in female may be due to blood adiponectin and circulating oestrogen levels<sup>20</sup>. Hence, the WC related to central obesity is more predictive for the female than for the male population, this is in agreement with Kang et al.

## CONCLUSION

The present study reports female gender and increased waist circumference are risk factors for the hearing loss. This study shows null hypothesis was rejected and alternate hypothesis was accepted which proved that there was association between increased waist circumference and hearing loss and was found more in female gender.

## RECOMMENDATIONS

The present study recommends:

- Large scale and large sample sized prospective studies are recommended.
- Auditory screening of obese subjects should be carried at an early stage to prevent hearing morbidity.
- Public awareness campaigns should be carried out regarding obesity and possible side effects related with hearing loss.

## REFERENCES

1. Curhan SG, Eavey R, Wang M, Stampfer MJ, Curhan GC. Body Mass Index, Waist Circumference, Physical Activity, and Risk of hearing loss in women. *Am J Med* 2013; 126 (12):1142.e1-1142.8. doi: 10.1016/j.amjmed.2013.04.026
2. Elzouki AY, Harfi HA, Nazer HM, Stapleton FB, Oh W, Whitley RJ. Text book of clinical pediatrics

- 2nd eds. Berlin Springer Berlin 2012.
3. Ucler R, Turan M, Garca F, Acar I, Atmaca M, Cankaya H. The association of obesity with hearing thresholds in women aged 18-40 years. *Endocrine* 2016; 52(1):46-53. doi: 10.1007/s12020-015-0755-y.
4. Lalwani AK, Katz K, Liu YH, Kim S, Weitzman M. Obesity is associated with sensorineural hearing loss in adolescents. *Laryngoscope* 2013; 123(12):3178-84. doi: 10.1002/lary.24244.
5. Eknayan G. Adolph Quetelet (1796-1874) - the average man and indices of obesity. *Nephrol Dial Transplant* 2007; 23(1):47-51.
6. Helzner EP, Patel AS, Pratt S, Sutton Tyrrell K, Cauley JA, Talbott E, et al. Hearing sensitivity in older adults: associations with cardiovascular risk factors in the health, aging and body composition study. *J Am Geriatr Soc* 2011; 59(6):972-9. doi: 10.1111/j.1532-5415.2011.03444.x.
7. Fransen E, Topsakal V, Hendrickx JJ, et al. Occupational noise, smoking, and a high body mass index are risk factors for age-related hearing impairment and moderate alcohol consumption is protective: a European population-based multicenter study. *J Assoc Res Otolaryngol* 2008; 9(3):264-76. doi: 10.1007/s10162-008-0123-1.
8. Hwang JH, Wu CC, Hsu CJ, Liu TC, Yang WS. Association of central obesity with the severity and audiometric configurations of age-related hearing impairment. *Obesity (Silver Spring)* 2009; 17(9):1796-801. doi: 10.1038/oby.2009.66
9. Flint AJ, Rexrode KM, Hu FB, Glynn RJ, Caspard H, Manson JE, et al. Body mass index, waist circumference, and risk of coronary heart disease: a prospective study among men and women. *Obes Res Clin Pract* 2010; 4(3):e171-e181.
10. Jaffat TH, Chaturvedi N, Pappas G. prevalence of overweight and obesity and their association with hypertension and diabetes mellitus in an Indo Asian population. *CMAJ* 2006; 175(9): 1071-7
11. da Silva Magalhães EI, da Rocha Sant'Ana DF, Priore SE, do Carmo S, Franceschini C. Waist circumference, waist/height ratio, and neck circumference as parameters of central obesity assessment in children. *Revista Paulista de Pediatria* 2014; 32(3): 273-282.
12. Lee J, Han K, Song JJ, Im GJ, Chae SW. Sarcopenia and Hearing Loss in Older Koreans: Findings from the Korea National Health and Nutrition Examination Survey (KNHANES) 2010. *PLoS ONE* 2016; 11(3):e0150281.
13. Jung DJ, Jang JH, Lee KY. Is Body Mass Index Associated With the Development of Age-Related Hearing Impairment in Koreans? The Korean National Health and Nutrition Examination Survey 2009-2012. *Clin Exp Otorhinolaryngol* 2016; 9(2):123-130. doi: 10.21053/ceo.2015.00955
14. Kang SH, Jung DJ, Cho KH, Park JW, Yoon KW, Do JY. The Association between Metabolic Syndrome or Chronic Kidney Disease and Hearing Thresholds in Koreans: The Korean National Health and Nutrition Examination Survey 2009-2012. *PLoS ONE* 2015; 10(3): e0120372. <https://doi.org/10.1371/journal.pone.0120372>.
15. Cruickshanks KJ, Nondahl DM, Dalton DS, Fischer ME, Klein BE, Klein R, et al. Smoking, central adiposity, and poor glycemic control increase risk of hearing impairment. *J Am Geriatr Soc* 2015;63(5):918-24. doi: 10.1111/jgs.13401.
16. Jennings MB, Shaw L. Impact of hearing loss in the workplace: raising questions about partnerships with professionals. *Work* 2008; 30(3):289-95.
17. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. *Obes Rev* 2012; 13(3):275-86. doi: 10.1111/j.1467-789X.2011.00952.x
18. Ko KP, Oh DK, Min H, Kim CS, Park JK, Kim Y, et al. Prospective study of optimal obesity index cutoffs for predicting development of multiple metabolic risk factors: the Korean genome and epidemiology study. *J Epidemiol* 2012;22(5):433-9.
19. Shargorodsky J, Curhan SG, Eavey R, Curhan GC. A prospective study of cardiovascular risk factors and incident hearing loss in men. *Laryngoscope* 2010; 120(9):1887-91. doi: 10.1002/lary.21039.
20. Lee H, Oh JY, Sung YA. Adipokines, insulin-like growth factor binding protein-3 levels, and insulin sensitivity in women with polycystic ovary syndrome. *Korean J Intern Med* 2013; 28(4):456-63. doi: 10.3904/kjim.2013.28.4.456.

**AUTHOR AFFILIATION:**

**Dr. Samina Sheikh**

Department of Physiology  
Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Sindh-Pakistan.

**Dr. Rubina Ahmedani**

Department of Physiology  
LUMHS, Jamshoro, Sindh-Pakistan.

**Dr. Tazeen Shah** (Corresponding Author)

Department of Physiology  
LUMHS, Jamshoro, Sindh-Pakistan.  
Email: shahtazeen@yahoo.com